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63-2-4

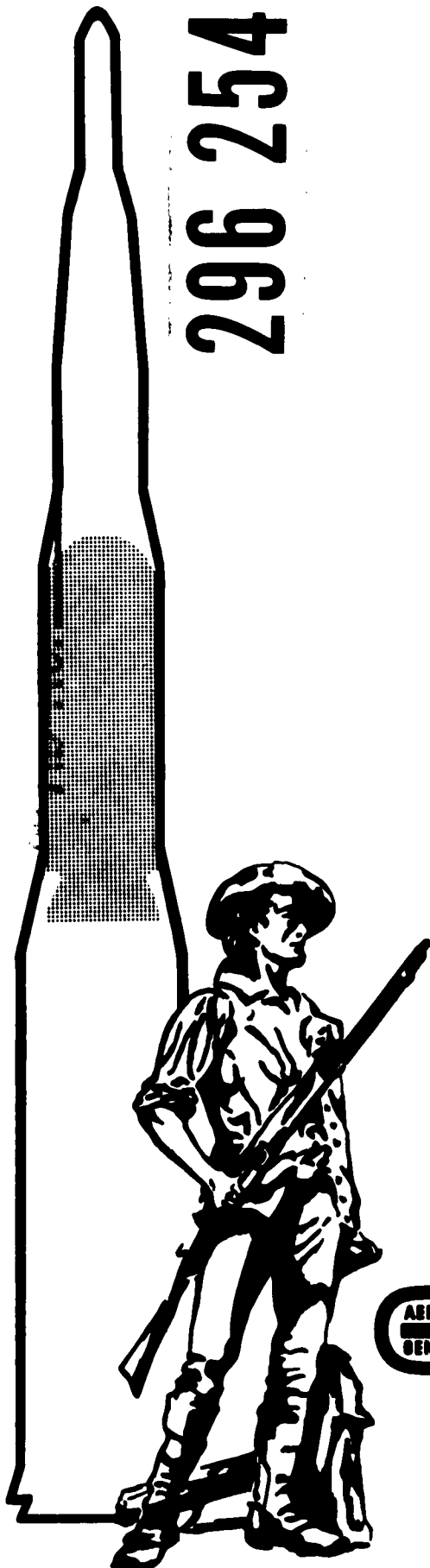
19 December 1962

Report No. 0162-01TN-62-18

HIGH- AND LOW-TEMPERATURE TESTS
OF THE AEROJET UTILITY VAN

AFBSD Technical Note BSD-TDR-62-331

Contract No. AF 33(600)-36610



AEROJET-GENERAL CORPORATION

SOLID ROCKET PLANT • SACRAMENTO, CALIFORNIA
A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

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Prepared for

HQ., AIR FORCE BALLISTIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
AIR FORCE UNIT POST OFFICE
Los Angeles 45, California
ATTN: Tech Data Center

Approved by:


C. C. Conway, Manager
Minuteman Program



SOLID ROCKET PLANT SACRAMENTO, CALIFORNIA

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

PREFACE

Acknowledgment is made to the following persons for the preparation of this report: Jack D. Sohl, Environmental Program Engineer; C. M. McCarty, Environmental Testing Department; Max Halebsky, Minuteman Environmental Program; and D. P. Campbell, Technical Editor.



ABSTRACT

The Aerojet-General Utility van has successfully completed high- and low-temperature tests to verify the acceptability of the van as a transport vehicle for second-stage Minuteman operational motors. A Minuteman motor cast with propellant simulant was used in the tests. While the exterior of the van was subjected to high and low temperatures, ranging from +140 to -35°F, the surface of the motor was maintained within the specified temperature range of $80 \pm 20^\circ\text{F}$.



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I. INTRODUCTION

To verify the acceptability of the Aerojet Utility van, manufactured by the Utility Trailer Manufacturing Co., as a transport vehicle for Minuteman second-stage operational motors, the van was subjected to high- and low-temperature tests at Eglin Air Force Base, Florida. An inert second-stage motor was housed in the van. These tests were made in conjunction with structural verification tests of the van following completion of the Aerojet Utility Van Certification Program.

II. TECHNICAL DISCUSSION

A. TEST UNITS

1. Test Facility

The climatic testing was done in the Engine Test Cell, Climatic Laboratory, Air Proving Ground Center, Eglin AFB, Florida. The Aerojet Utility van installed in the cell is shown in Figure 1.

2. Aerojet Utility Van

The Aerojet Utility van is a trailer designed to house a Minuteman second-stage operational motor while in transit by ground or air transport. The test van, model VR-1152A, SN 37290 (AF 348873), had been modified in accordance with Aerojet drawing T-492674.

3. Heating and Cooling Unit

The interior temperature of the van was regulated by a Thermo-King temperature-control unit, Model K30A. The unit, installed on the exterior forward wall of the van (Figure 2), provided heat from three heater strips powered by



II, A, Test Units (cont.)

220 vac. Cooling was provided by the refrigeration section of the unit. In accordance with standard summer practice, the louvered top cover and shutters of the unit had been removed.

4. Test Motor

The test motor was Minuteman second-stage motor 44TE-1, (SN 519592). The motor had been cast with propellant simulant.

B. INSTRUMENTATION

The motor and interior of the van was instrumented with 26 iron-constantan thermocouples (Figure 3) to determine motor-surface and van-interior temperature gradients. All temperature data were continuously recorded on two Minneapolis-Honeywell Brown print-out recorders, Model No. RY153X82-C-II-III (13), serial numbers 322005 and 314315 (shown in Figure 4 with standard reference junction). Calibration input voltage for each 10°F from -50 to $+200^{\circ}\text{F}$ was applied to each channel by a Leeds-Northrup potentiometer, Model K-2. A plot of this calibration is shown in Figure 5. A continuous $+150^{\circ}\text{F}$ reference point was provided on each recorder by a standard reference junction manufactured by Pace Engineering Company. Figures 6 through 9 show the instrumentation of the motor. Figure 10 shows the thermocouple termination at the aft end of the Utility van.

C. TEST CONDITIONS

In accordance with Aerojet Test Plan 752, Revision A, the Utility van was subjected to high- and low-temperature tests. The low extreme was $-35 \pm 5^{\circ}\text{F}$, and the high extreme was $+140 \pm 5^{\circ}\text{F}$, including 15°F as radiant energy of the sun.

1. Low-Temperature Test

With the motor surface temperature at $80 \pm 5^{\circ}\text{F}$, the temperature of the test cell was reduced to -35°F and held until 4 hr after the surface temperature



II, C, Test Conditions (cont.)

of the motor had stabilized. Then the Thermo-King unit was switched off and temperatures were monitored for another 4 hr while the test-cell temperature remained at -35°F .

2. High-Temperature Test

After the motor surface temperature returned to and was stabilized at 80°F , the temperature of the conditioning cell was increased to $+140^{\circ}\text{F}$ and held for 4 hr. The Thermo-King unit was then switched off. While the temperature of the test cell was maintained at $+140^{\circ}\text{F}$, temperature data were recorded for another 4 hr.

D. TEST RESULTS

1. General

Instrumentation of the Utility van and inert motor was completed at Aerojet-General, Sacramento prior to shipment. The tractor-van, traveling over conventional highway routes, arrived at Eglin AFB, Florida on 30 July 1962.

No major operational difficulties or malfunctions of equipment or instruments occurred during the tests. The temperature of the test cell was maintained within the specified tolerances. Air temperatures at the forward and aft areas of the van were recorded throughout the tests. A buildup of ice and frost near the top seal at the aft doors of the van indicated a source of heat loss during the low-temperature test.

All test objectives were accomplished satisfactorily. The tests were witnessed by an inspector representing the Air Force Systems Command, Field Test Office. Inspection and documentation were accomplished in accordance with Minuteman Engineering and Inspection Summary (MEIS) HT-62, as given in Appendix A.



II, D, Test Results (cont.)

Appendix B lists recorded temperatures for the low- and high-temperature tests. Test events are listed chronologically in Appendix C.

2. Low-Temperature Test

Calibration of instruments and preparation of the test cell were completed on 8 August. On 9 August, the Utility van was positioned in the cell and installation of the exhaust-gas duct, servicing of the Thermo-King unit, and thermocouple termination were completed.

At 1030 hours on 9 August, temperature conditioning of the cell was started. The required low temperature of $35 \pm 5^{\circ}\text{F}$ for the interior of the cell was recorded at 1500 hours and temperature stabilization of the motor began. The test proceeded without incident except for a period of 1.5 hr during which the operation of the Thermo-King unit was intermittent. A defective circuit in post-to-fuse connection was discovered, and corrective action was taken. At 0700 hours on 10 August, 16 hr after the test began, the surface temperature of the motor stabilized at $+60^{\circ}\text{F}$. At 1100 hours, the Thermo-King unit was switched off. The average van-interior and motor-surface temperatures at this time were 59 and 60°F , respectively. After 4 hr without heating, the temperature recordings of the van interior ranged from 32 to 38°F , and the motor-surface temperature ranged from 45 to 49°F . An attempt to restart the Thermo-King unit on conclusion of the test was unsuccessful. At 1505 hours, the cell temperature was returned to $+80^{\circ}\text{F}$ and the van doors were opened. Figures 11 and 12 show the recorded low-temperature data in graph form.

3. High-Temperature Tests

At 0745 hours on 13 August, temperature conditioning of the cell was started. The required high temperature of $+140 \pm 5^{\circ}\text{F}$ was recorded at 0900 hours. Since van-interior temperatures ranged from 74 to 77°F , the thermostat setting of the Thermo-King unit was reduced from 80 to 75°F to



II, D, Test Results (cont.)

prevent commencement of the heating cycle. The Thermo-King unit was manually switched on at 0915 hours for a functional check of the unit. This resulted in a drop of the van-interior temperature between 0930 and 1000 hours. The 4-hr test period was completed at 1305 hours when the motor-surface temperature was +87°F and the average van-interior temperature was +89°F. The Thermo-King unit was then switched off and the unit remained inoperative for 4 hr. The highest motor-surface temperature recorded during this period was +94°F, and the highest van-interior temperature was +104°F. At 1706 hr, the Thermo-King unit was operated for 10 min. The van-interior temperature was reduced to an average of +90°F, and the motor-surface temperature to +88°F. Figures 13 and 14 show the high-temperature data in graph form.

III. CONCLUSIONS

During the low-temperature tests, the motor-surface equilibrium temperature was determined to be +60°F. During the high-temperature test, the highest motor-surface temperature recorded was +87°F. Therefore, on the basis of the acceptance criteria as given in Space Technology Laboratories, Inc., document 62-9731.3-523, dated 22 March 1962, the Aerojet Utility van is acceptable as a transport vehicle for Minuteman second-stage operational motors.

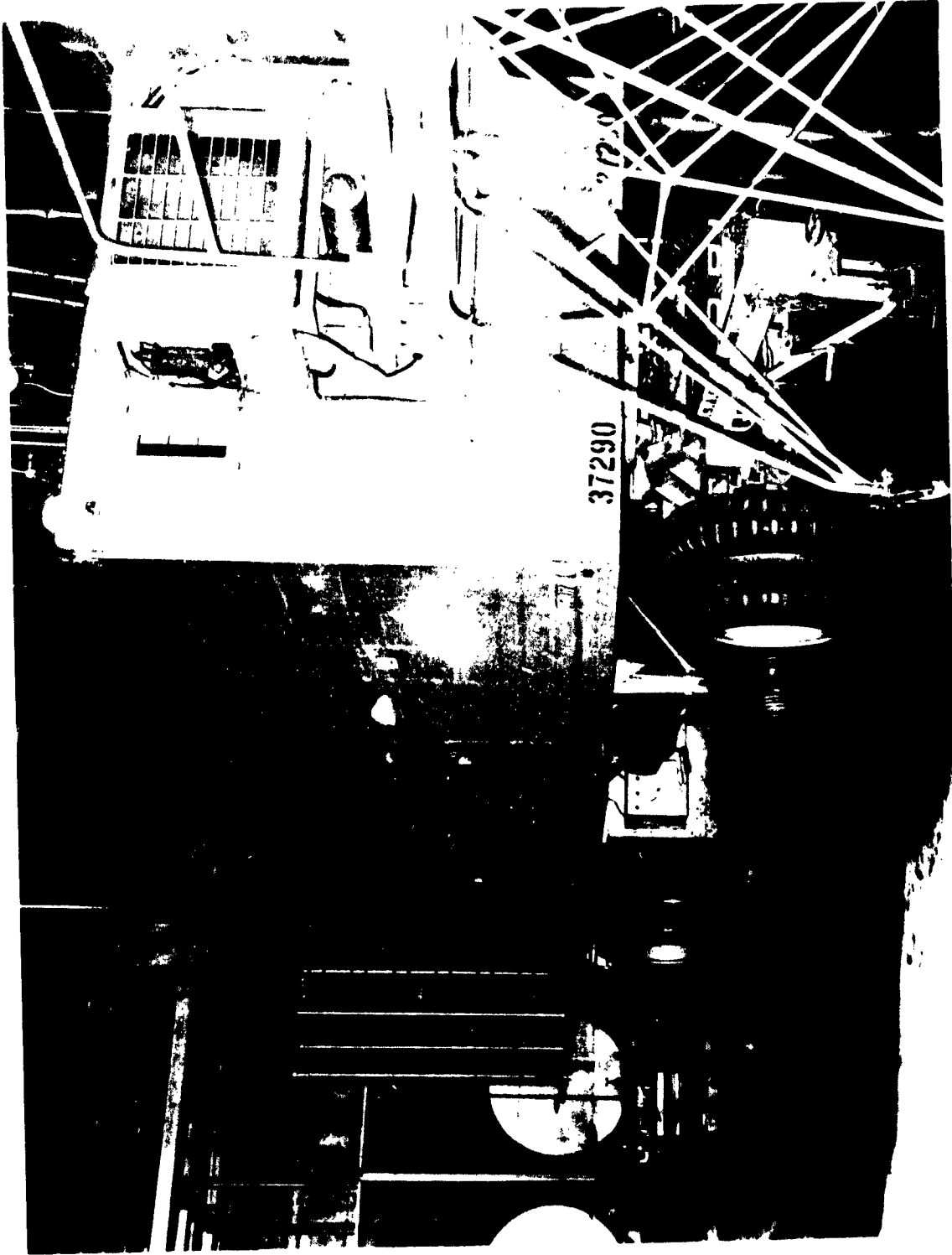
Data obtained when the Thermo-King temperature-control unit was not operating indicate that an actual malfunction of the unit (occurring under temperature conditions similar to those imposed during the tests) would not adversely affect a Minuteman motor. If the motor-surface temperature was at +80°F at time of unit failure, the motor-surface temperature would not increase beyond 100°F during the first 10 hr of exposure to the high-temperature extreme (+140°F). Similarly, during 10 hr of exposure to the low-temperature extreme (-35°F), the motor-surface temperature would not fall below +40°F.



III, Conclusions (cont.)

During the operation of the Thermo-King unit, the temperature within the van remained steady. A variance of 2°F was the greatest recorded. Data obtained indicate the mode of temperature stratification during periods when the Thermo-King unit is not operating. The temperature of the air layer at the ceiling of the van is 6°F higher than the air layer at the floor of the van. There is no apparent difference in air temperature in the fore and aft sections of the van.





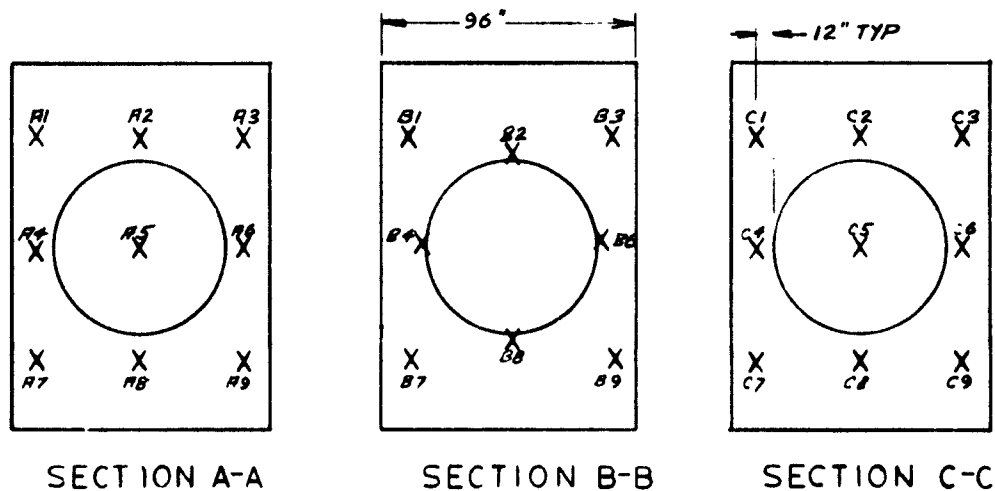
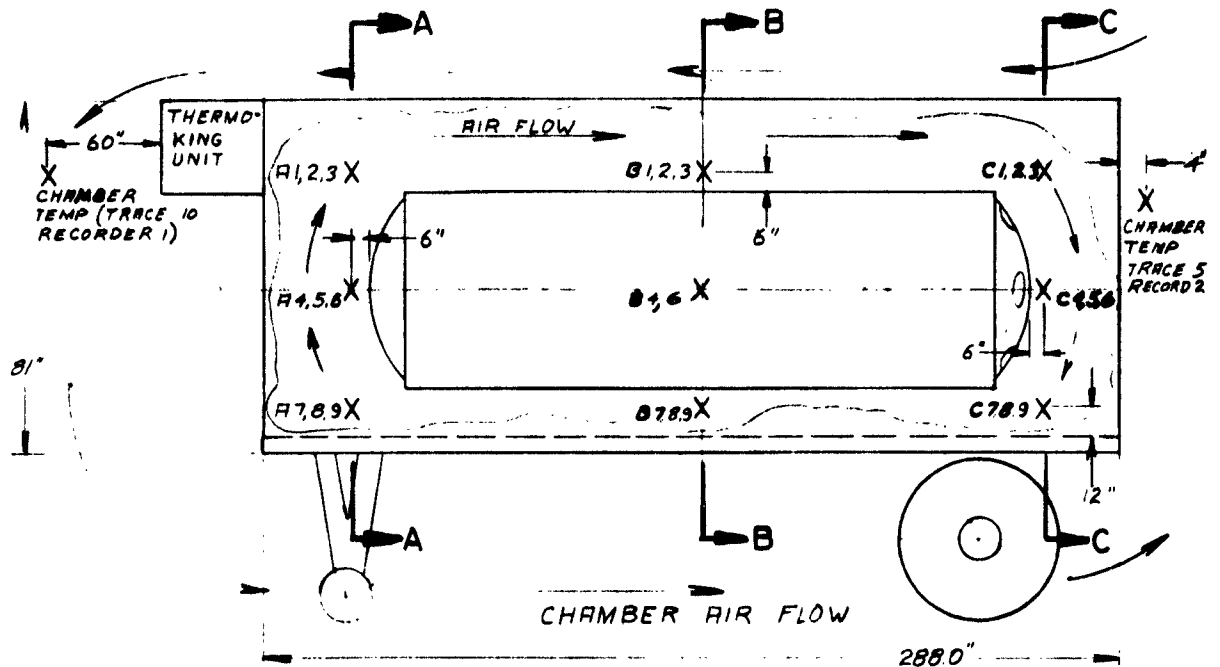
Aerojet Utility Van in Engine Test Cell, Climatic Laboratory, Air Proving
Ground Center, Eglin Air Force Base, Florida

Figure 1



Thermo-King Temperature-Control Unit Installed on Aerojet Utility Van
(View of Right-Forward Corner of Van)

Figure 2



Note:

1. All free air thermocouples are secured to prevent swinging caused by air flow.
2. Thermocouples B2, B4, B6 and B8 are measuring motor surface temperature.

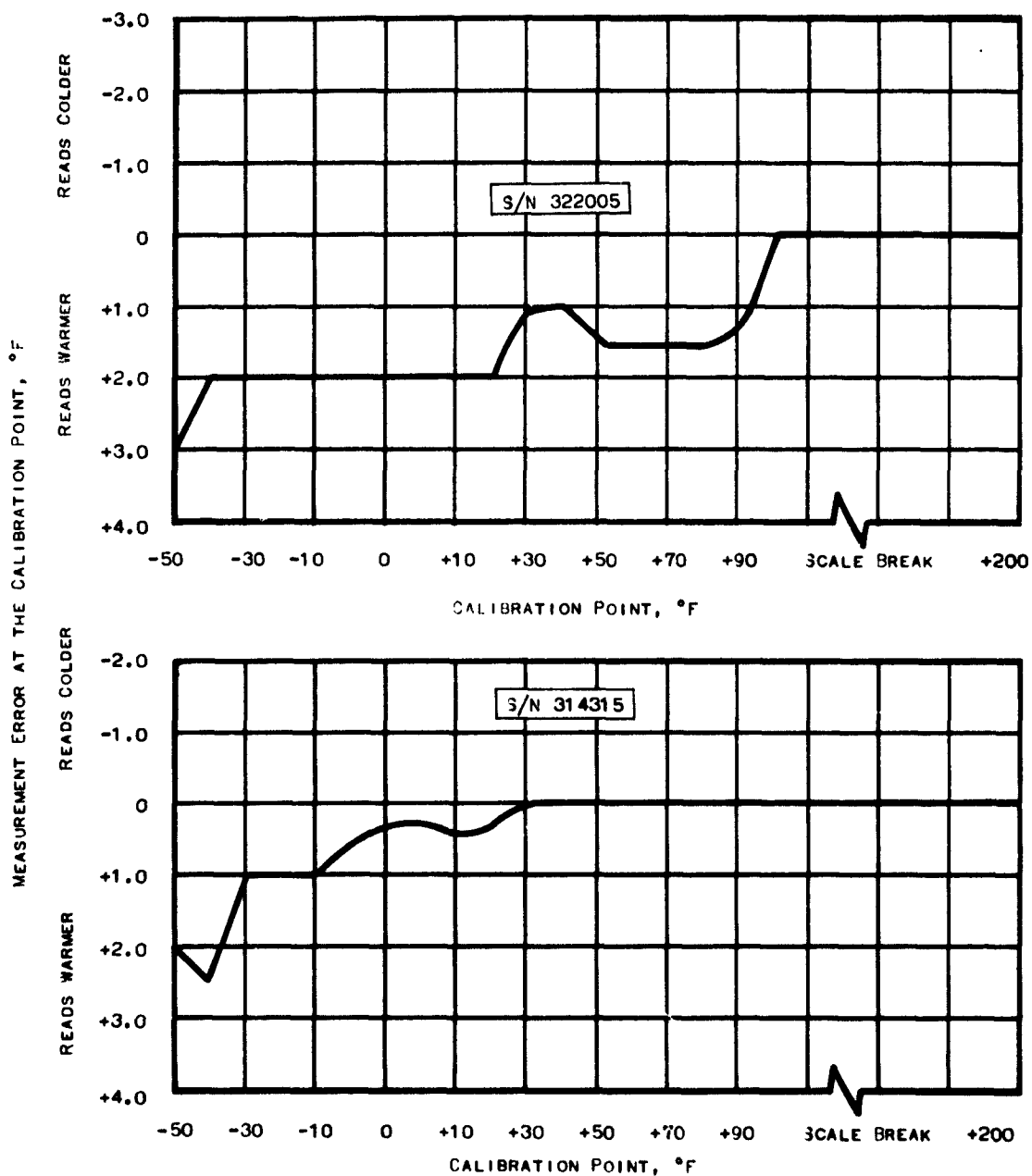
Locations and Designations of Thermocouples

Figure 3



Minneapolis-Honeywell Brown Print-Out Recorder and Standard
Reference Junction

Figure 4

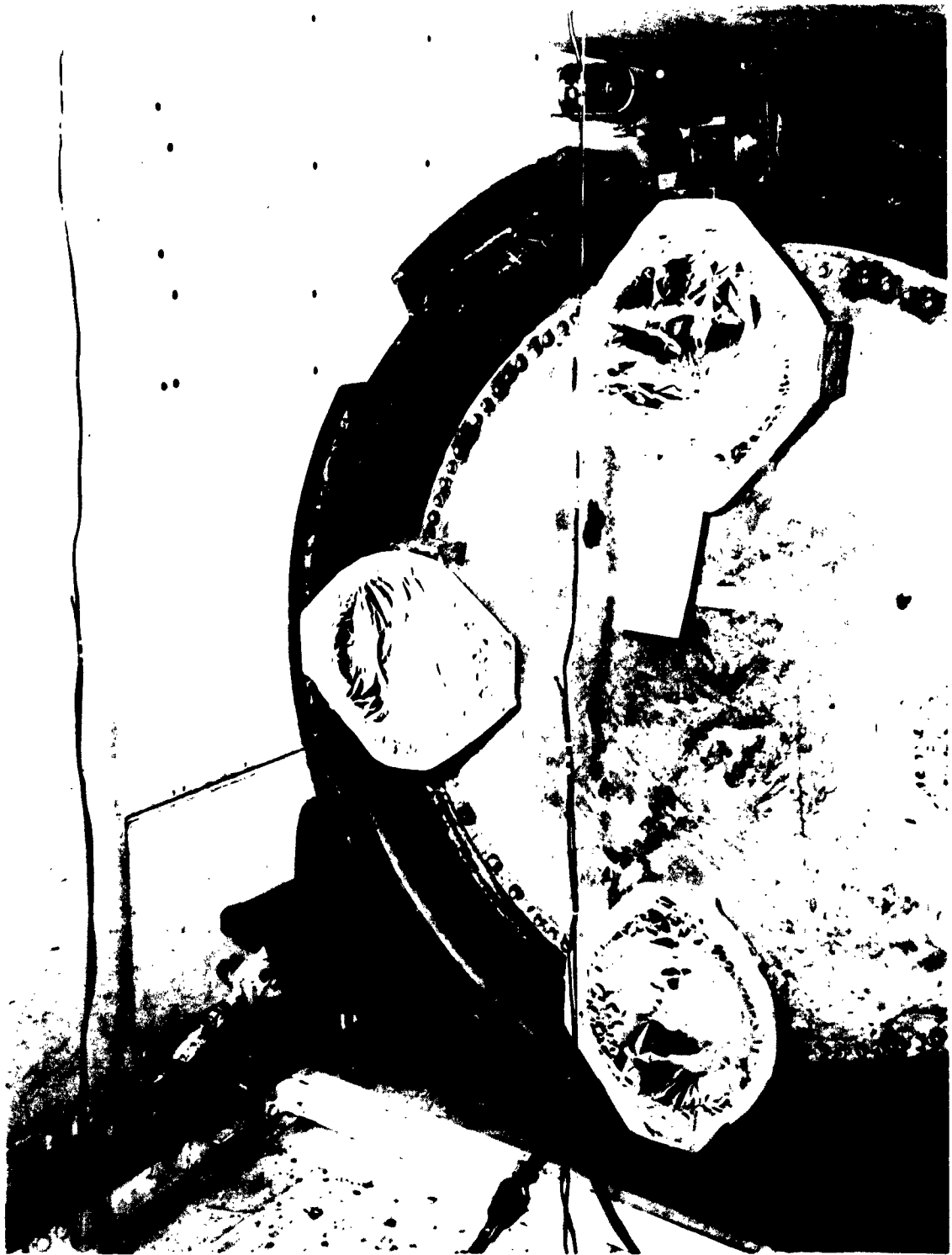
BROWN RECORDER
CALIB. CURVESMM2-QZ-023-TC01-1
UTILITY VAN CLIMATIC
VERIFICATION TEST
EGLIN AFB, FLORIDACALIBRATION INPUT VOLTAGE AT EACH POINT SUPPLIED BY LEEDS AND NORTHRUP
K-2 POTENTIOMETER.

CALIBRATIONS OBTAINED ON 8 AUGUST 1962.

ORIGINAL CALIBRATION RECORDS ON FILE WITH AFSC FIELD TEST SECTION, EGLIN AFB, FLORIDA.

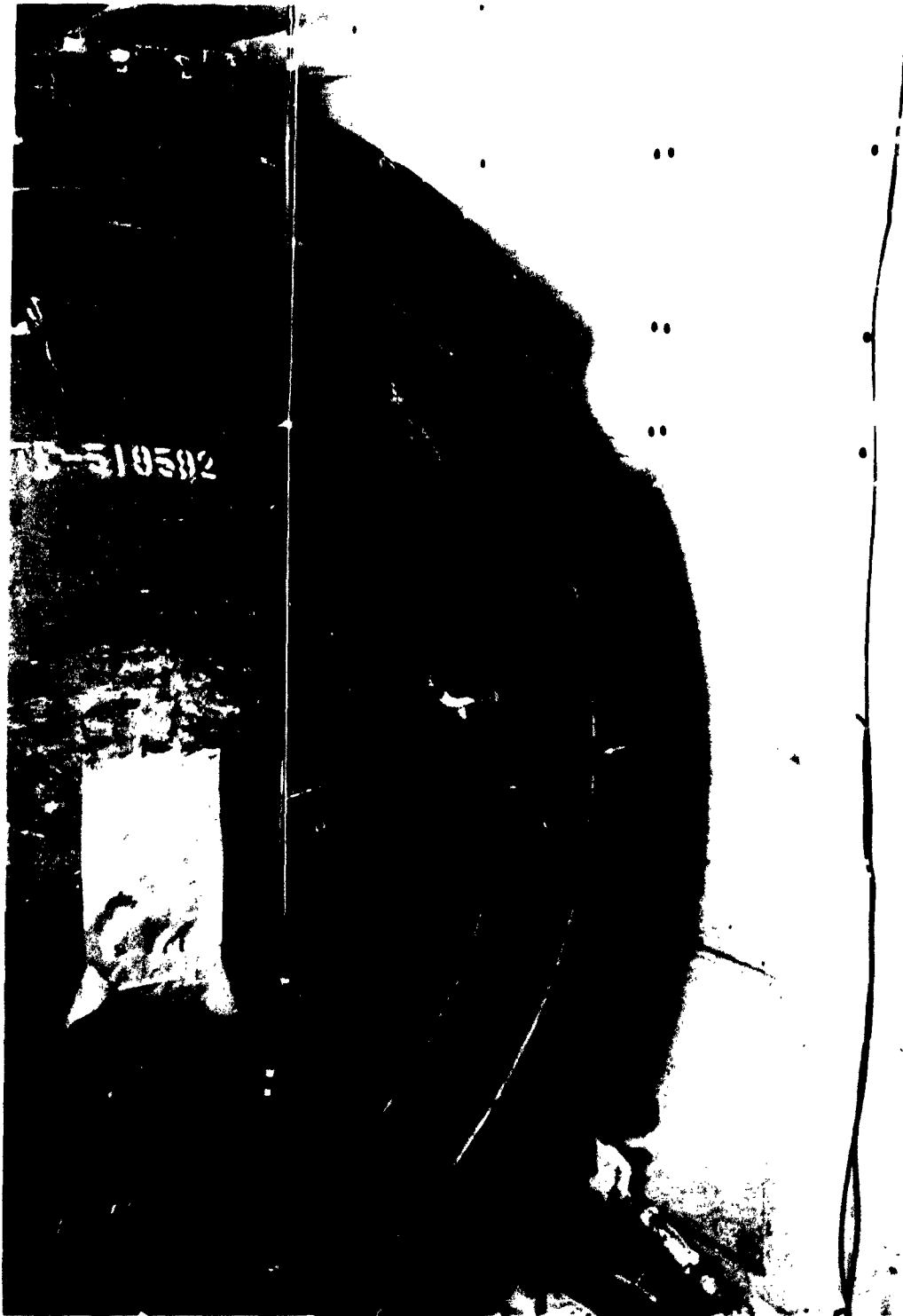
Calibration Plot of Print-Out Recorders

Figure 5



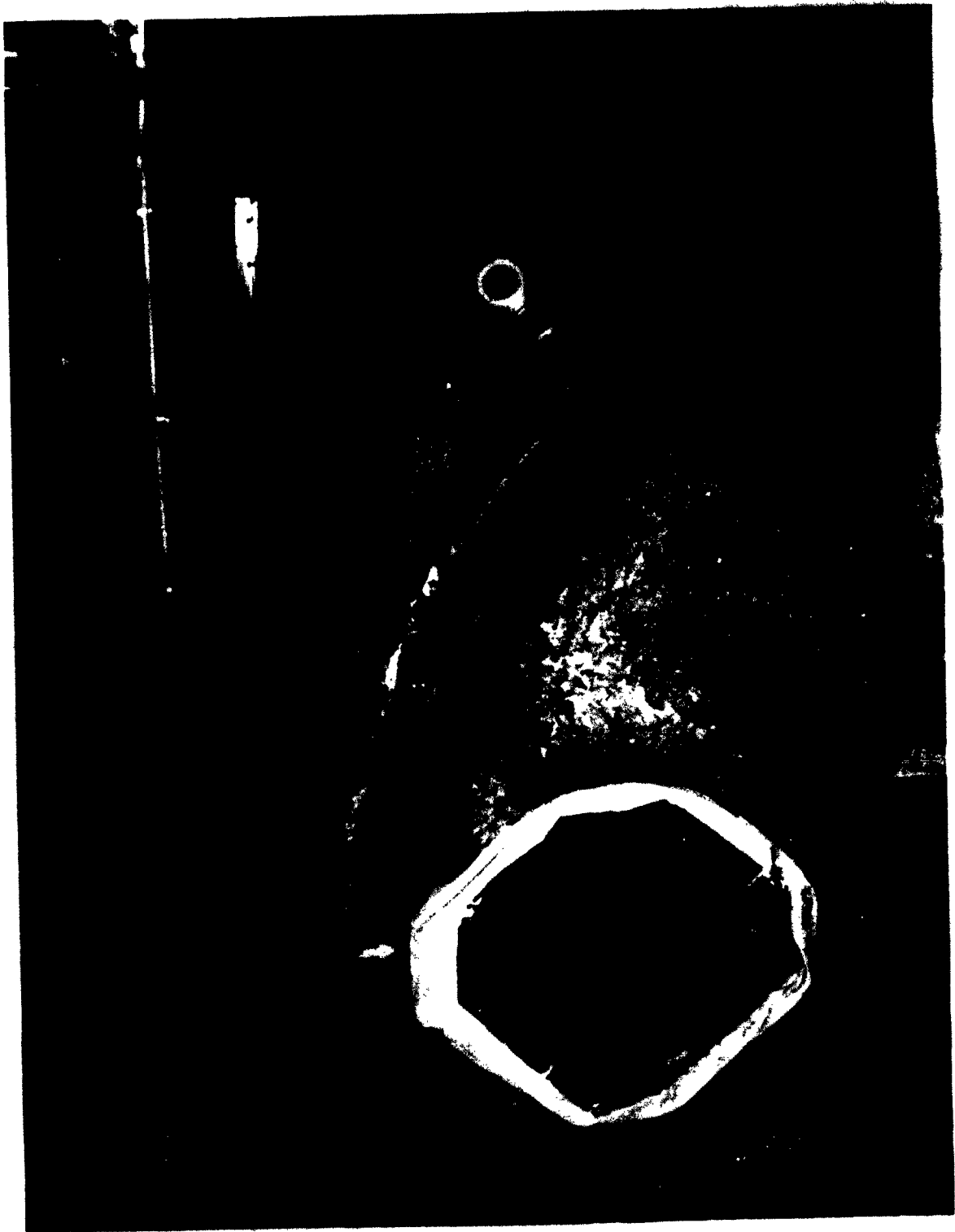
Instrumentation at Aft End of Motor

Figure 6



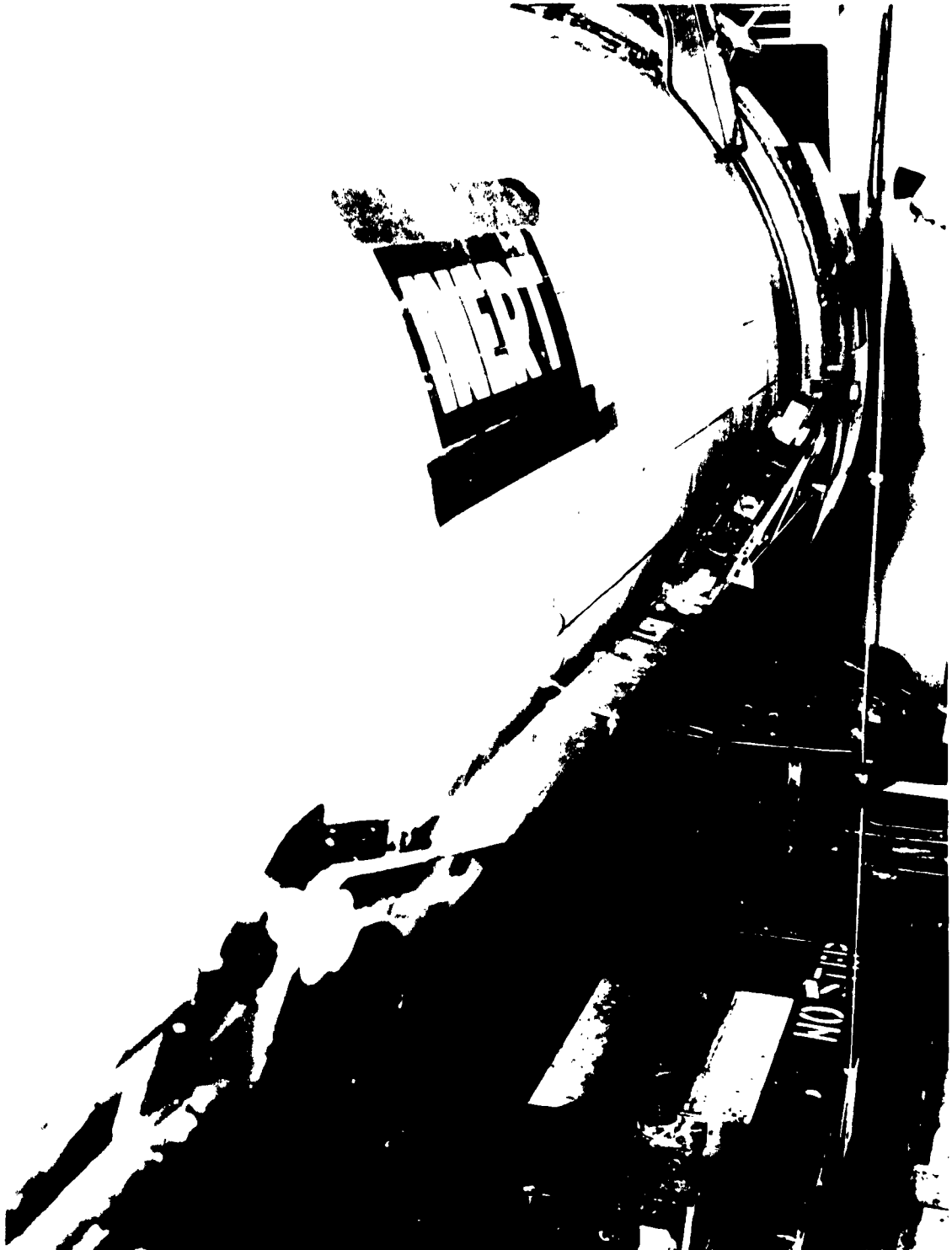
Instrumentation at Forward End of Motor

Figure 7



Instrumentation at Left Side of Motor

Figure 8



Instrumentation at Right Side of Motor

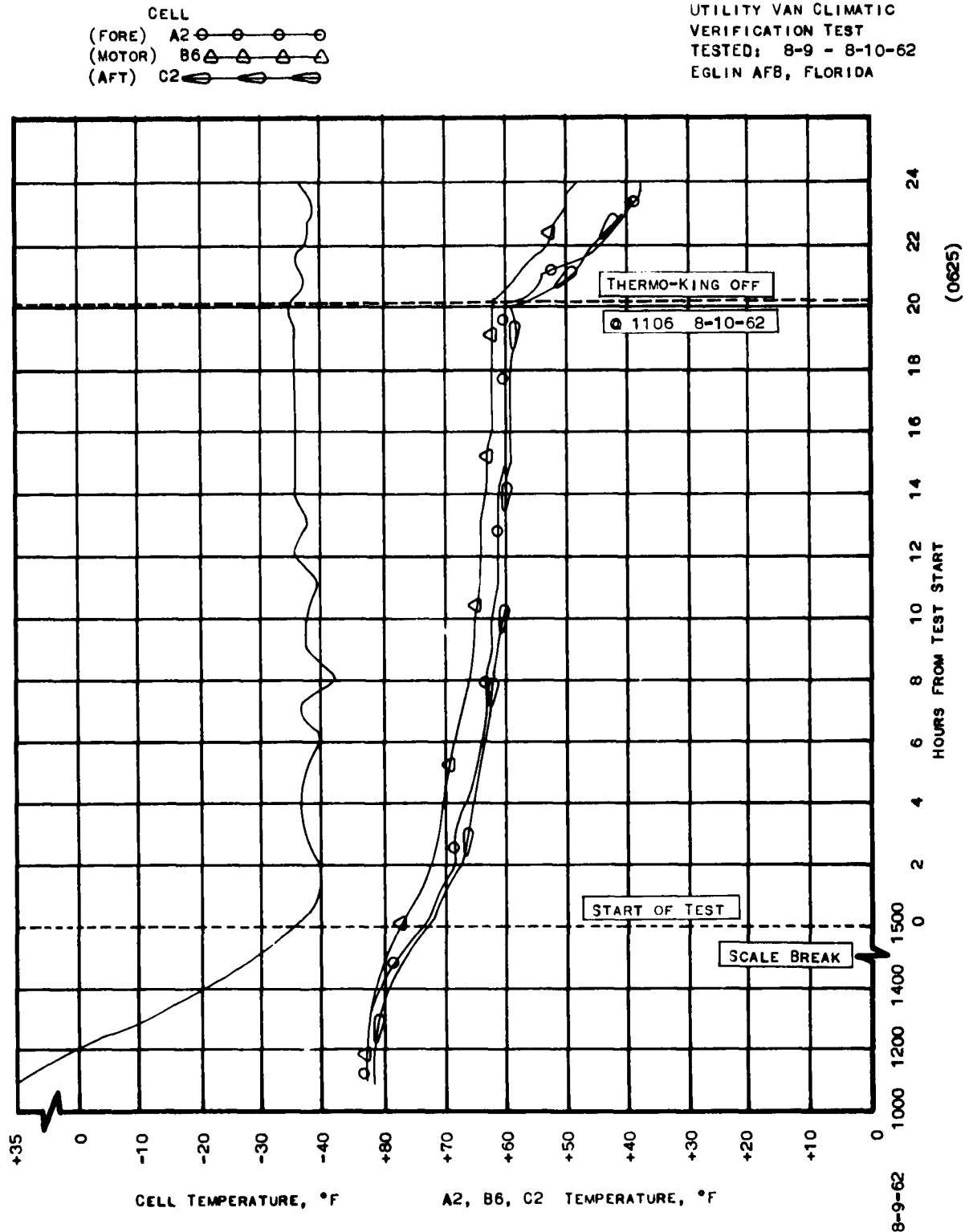
Figure 9



Thermocouple Termination at Aft End of Utility Van

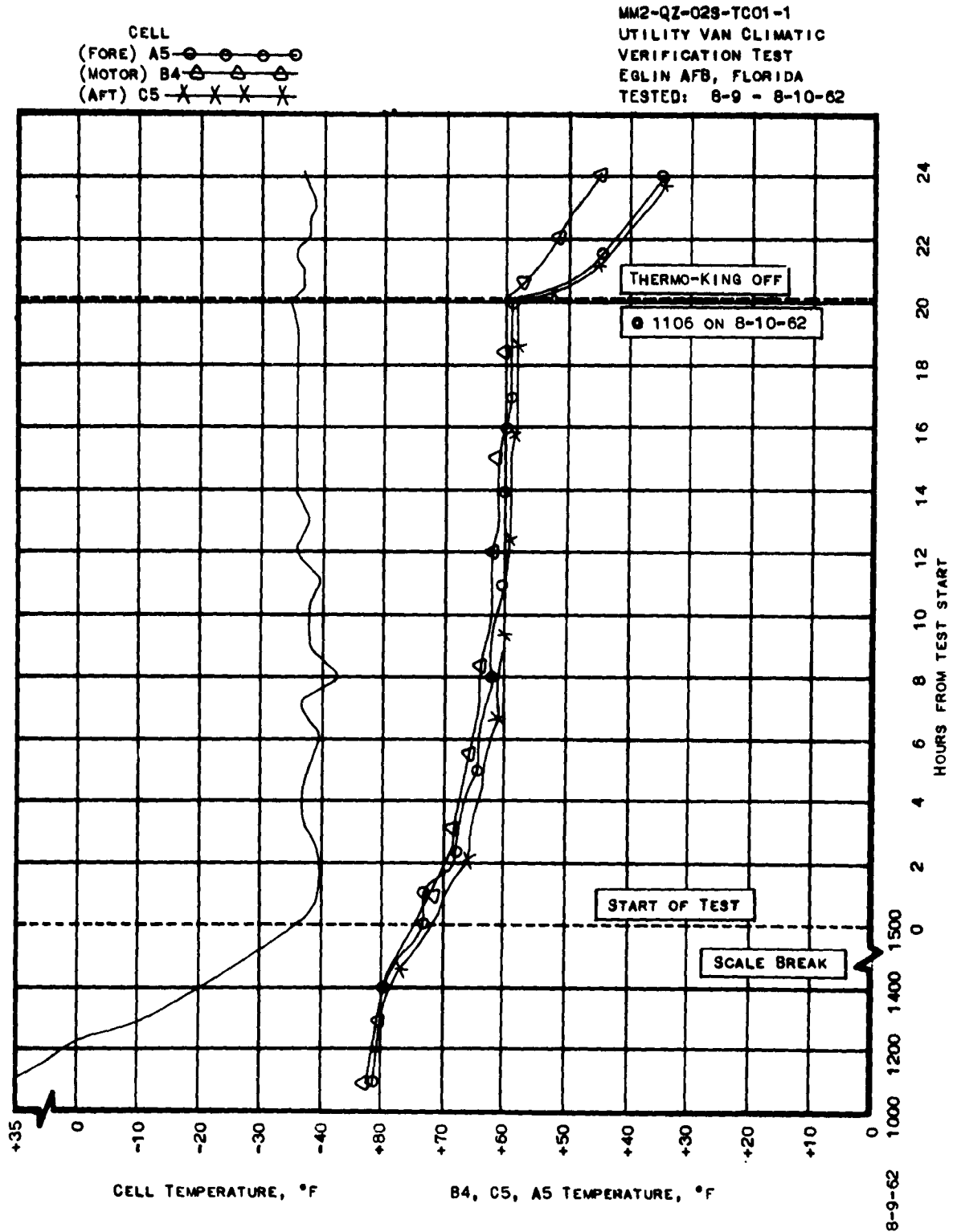
Figure 10

MM2-QZ-02S-TC01-1
 UTILITY VAN CLIMATIC
 VERIFICATION TEST
 TESTED: 8-9 - 8-10-62
 EGLIN AFB, FLORIDA



Low-Temperature Test Data (Plot of Thermocouples A2, B6, and C2)

Figure 11

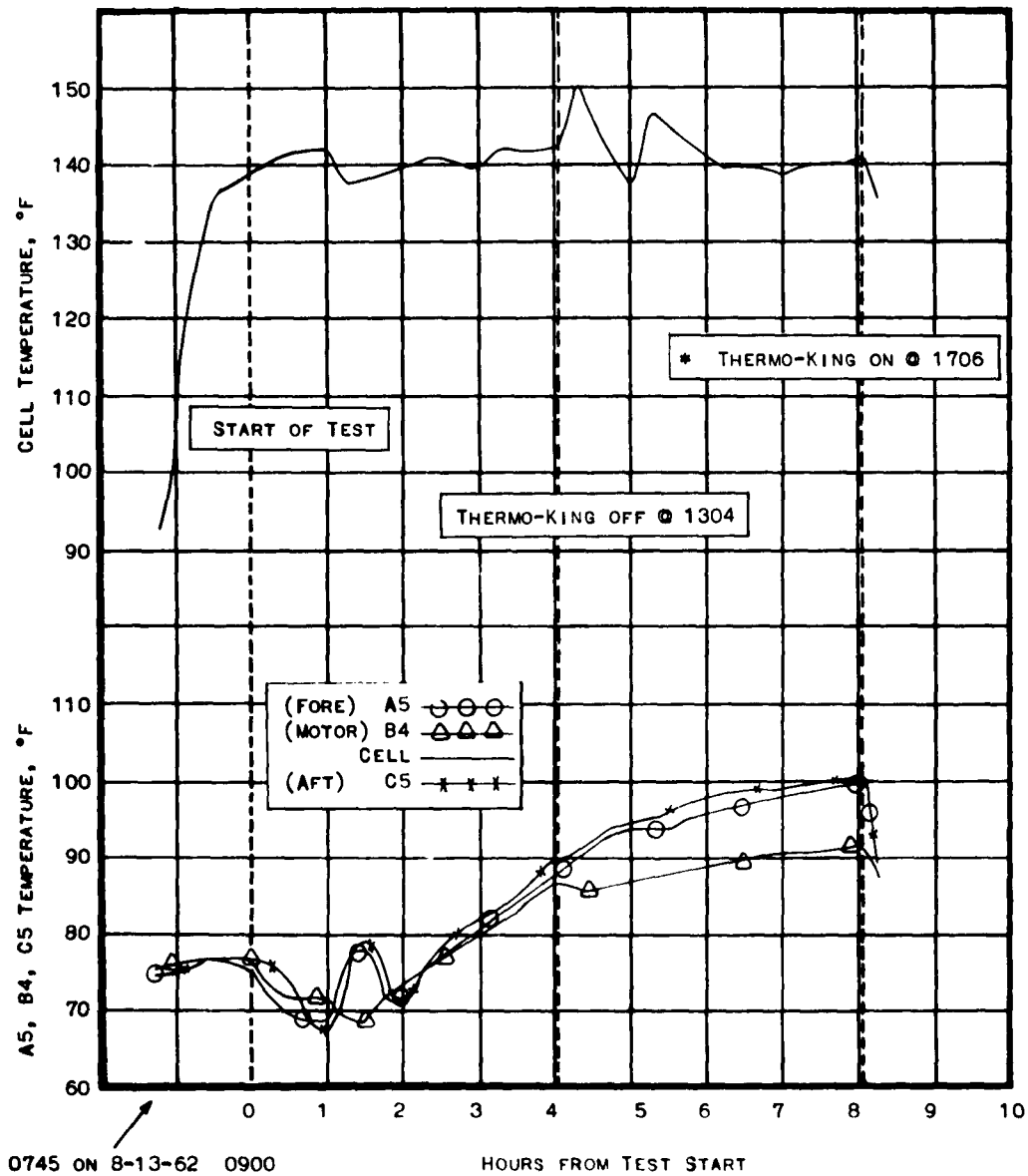


Low-Temperature Test Data (Plot of Thermocouples A5, B4, and C5)

Figure 12

* NOTE: THERMO-KING RESTART SUCCESSFUL
 @ 1706. UNIT LEFT RUNNING FOR
 10 MINUTES.

MM2-QZ-02S-TC01-1
 UTILITY VAN CLIMATIC
 VERIFICATION TEST
 EGLIN AFB, FLORIDA
 8-13-62

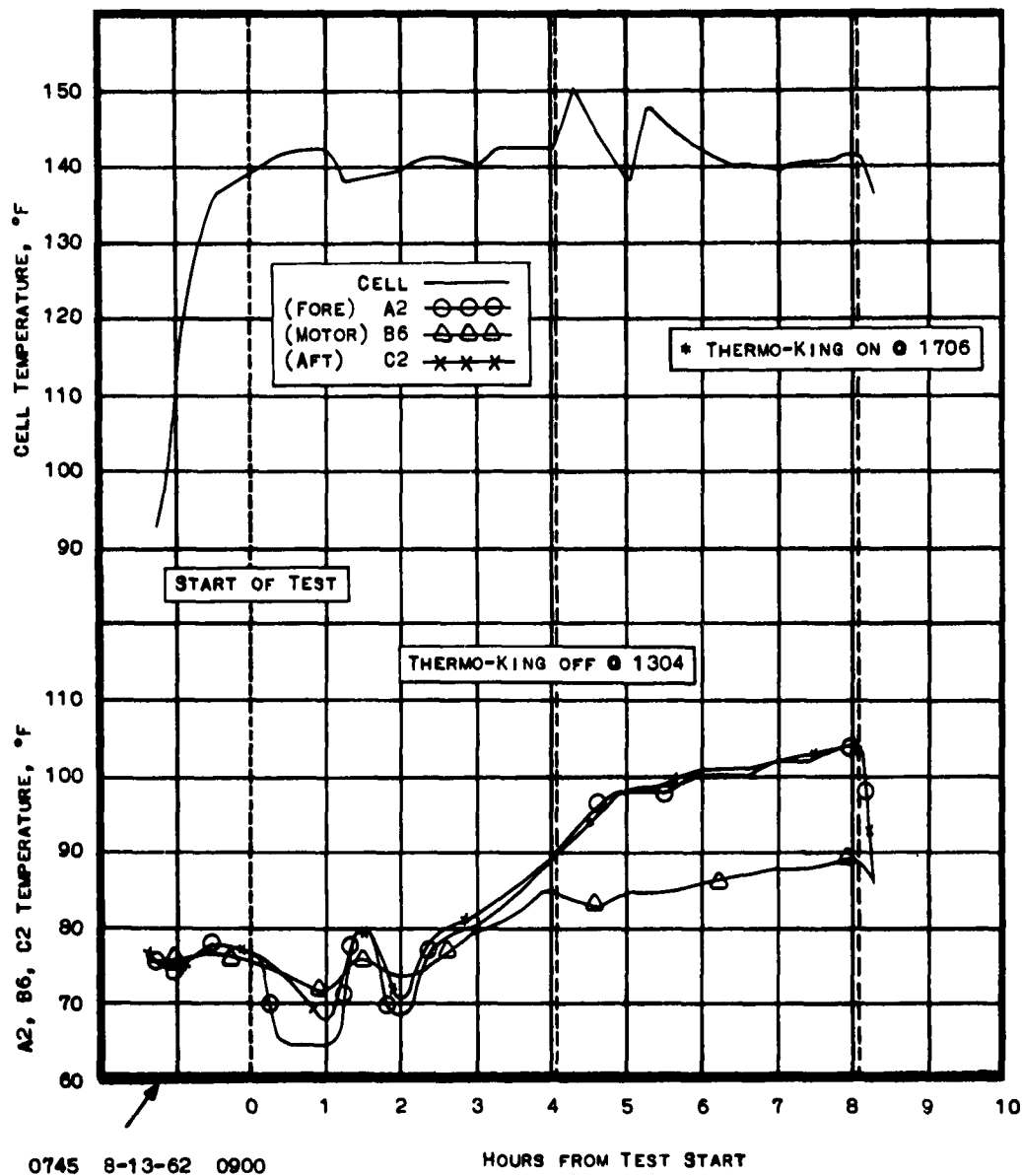


High Temperature Test Data (Plot of Thermocouples A2, B6, and C2)

Figure 13

* NOTE: THERMO-KING RESTART SUCCESSFUL
 @ 1706. UNIT LEFT RUNNING FOR
 10 MINUTES.

MM2-QZ-028-TC01-1
 UTILITY VAN CLIMATIC
 VERIFICATION TEST
 EGLIN AFB, FLORIDA
 8-13-62





High-Temperature Test Data (Plot of Thermocouples A5, B4, and C5)


Figure 14

APPENDIX A



Minuteman Engineering and Inspection Summary



AOC 3-053-03		AEROJET-GENERAL CORPORATION SOLID ROCKET PLANT SACRAMENTO, CALIF.				CODE 101	MES NO. HT-68	DATE 19 July 62	PAGE OF 1 of 1	SR NO. 1
MINUTEMAN INTEGRATED PLANNING RECORD		PREV. MES		NEXT MES		N.A. N.A.				
		APPLICABLE DWGS.: T-49267LA APPLICABLE SPECS.: Test Plan 752 A								
TITLE UTILITY VAN ENVIRONMENTAL VERIFICATION Verification n. VAN AF 348873 ENGINE NO. ACC 37290 SERIAL NO. USAF #3		OP. INIT.	INSPECTION SUMMARY CHANGES	INSP. STAMP	DATE AND REMARKS					
NO ENGINEERING CHANGES			NO INSPECTION CHANGES							
APPROVED:  * LINE 1 * SAFETY * WHEN REQUIRED		APPROVED: INSPECTION PLANNING 								

AGC Temp #35		MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		COB 101	MBIS NO.	ISSUE DATE	PAGE 10	OF 10
ENGINEERING INSTRUCTIONS		OF INIT.	INSPECTION SUMMARY	INSP. STAMP	REMARKS AND DATE			
<p>1.0 Scope</p> <p>1.1 This Minuteman Engineering and Inspection Summary covers the Engineering and Inspection requirements necessary to verify the acceptability of the 2nd Stage Minuteman Transporter (Utility Van) For operational use under extreme climatic conditions.</p> <p>2.0 References Required</p> <p>2.1 Test Plan 752, AGC Minuteman Division.</p> <p>2.2 Drawing T-492674A, Trailer, Transport, 44" motor.</p> <p>2.3 Contract change notification #182 to L. C. SALL to AF 33(600)-36610.</p> <p>2.4 Applicable drawings, sketches, specifications, and procedures in accordance with Page 1 of attached MIPR.</p> <p>3.0 Items to be Tested</p> <p>3.1 AGC 2nd Stage Minuteman Transporter, T-492674. S/N to be specified on the attached MIPR. Installed in the transporter is an inert 2nd Stage Minuteman Motor, 44TE-1, S/N 519592.</p> <p>3.2 K-30 manometer eyebo Thermo-King unit with 3-1/2 KW alternator heater assembly. (Assembled to trailer.)</p>								

AGC Temp #357

MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		MBIS NO.	ISSUE DATE	PAGE	OF 10
ENGINEERING INSTRUCTIONS		OP. INIT.	INSPECTION SUMMARY	INSP. STAMP	REMARKS AND DATE
<p>4.0 Test Equipment Furnished by AGC.</p> <p>4.1 Twenty-six thermocouples installed per Figure 1 of Test Plan 752.</p> <p>4.1.1 These thermocouples are of Iron-Constantan wire and are connected to a terminal strip on the aft end of the van. They are identified per Figure 1 of Test Plan 752.</p> <p>5.0 Test Equipment to be Furnished by APOC.</p> <p>5.1 Climatic chamber capable of maintaining temperature extremes of -35°F ($\pm 5^{\circ}$) and $+140^{\circ}$ ($\pm 5^{\circ}\text{F}$), and accommodating a transporter of the following dimensions: 11.25' high, 24.0' long, and 8.0' wide. (The loaded weight is approximately 23,000 pounds.)</p> <p>5.2 Temperature recording instruments capable of recording 26 channels of data, (Minneapolis-Honeywell Brown Electronic Strip Chart, Y153M62-PL6, or equivalent) with recording range of at least -50°F to $+150^{\circ}\text{F}$.</p> <p>5.3 Ducting to vent the exhaust gases of the Thermo-King unit to outside air.</p> <p>5.4 Lead-wire, Iron-Constantan, as required to connect each TC to the recording instrument.</p> <p>5.5 Still photography equipment.</p> <p>5.6 Tractor, with standard 5th wheel, for van movement as necessary</p>			<p>4.1 Verify thermocouples are located per Figure #1 of Test Plan 752 method: visual</p> <p>5.2 Temperature recorder has evidence of valid calibration. method: visual; verify per sticker on deck ACTUAL CALIB. RECORD,</p>	 	

AGC 3-052 12

MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		CODE 101	MEIS NO.	ISSUE DATE	PAGE 4 OF 10
ENGINEERING INSTRUCTIONS	OP. INIT.	INSPECTION SUMMARY			REMARKS AND DATE
<p>5.7 Gasoline for Thermo-King. (Standard, automotive)</p> <p>6.0 Engineering Instructions</p> <p>6.1 Pre-test procedures.</p> <p>6.1.1 Inspect condition of all internal thermocouples.</p> <p>6.1.1.1 All free-air TC's must be secured so as to prevent "singing-in-the breeze."</p> <p>6.1.1.2 All motor-mounted TC's must be firmly cemented to the chamber exterior.</p> <p>6.1.2 Inspect the general condition of the motor, harness, and tie-downs. List any discrepancies found.</p> <p>6.1.3 Perform functional check of the Thermo-King temperature control unit.</p> <p>6.1.4 Connect all thermocouple lead wires from recorder(s) to terminal strip.</p> <p>6.1.4.1 Record the following:</p>		<p>6.1.1.1 Verify free air thermocouples (Van t.c.s) Free from contact with van, and verify motor t.c. securely attached method: visual</p> <p><i>[Handwritten signature]</i></p>			

AGC Temp #35"		MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		MBIS NO.	ISSUE DATE	PAGE 5 OF 10
ENGINEERING INSTRUCTIONS		OP. INIT.	INSPECTION SUMMARY		INSPECTION STAMP	REMARKS AND DATE
<p>TC# Recorder #</p> <p>A1 /</p> <p>A2 /</p> <p>A3 /</p> <p>A4 /</p> <p>A5 /</p> <p>A6 /</p> <p>A7 /</p> <p>A8 /</p> <p>A9 /</p> <p>CELL</p> <p>B1 /</p> <p>B2 /</p> <p>B3 /</p> <p>B4 /</p> <p>B5 /</p> <p>B6 /</p> <p>B7 /</p> <p>B8 /</p> <p>B9 /</p> <p>REF</p> <p>C1 /</p> <p>C2 /</p> <p>C3 /</p> <p>C4 /</p> <p>C5 /</p> <p>C6 /</p> <p>C7 /</p> <p>C8 /</p> <p>C9 /</p> <p>CELL</p> <p>REF</p>	<p>Channel # (TRACE)</p> <p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24</p> <p>1 2 3 4 5 6</p>	<p>6 FEET IN FRONT OF VAN</p> <p>+130°F</p> <p>AT 9FT END OF VAN +150°</p>		<p>90 m</p>		

ACG Temp #35

MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		WDB 101	MEIS NO.	ISSUE DATE	PAGE 1 OF 10
ENGINEERING INSTRUCTIONS	OP. INIT.	INSPECTION SUMMARY			INSP. STAMP
<p>6.1.1.4.2 List recorder speed:</p> <p>Recorder No. <u>1</u> inches/hour</p> <p>Recorder No. <u>2</u> inches/hour</p> <p>Recorder No. <u>3</u> inches/hour</p> <p>6.1.1.4.3 All data channels checked for satisfactory operation.</p> <p>6.1.5 Still photos taken of internal instrumentation, recording system and general test set-up.</p> <p>6.1.6 Verify full fuel supply on Thermo-King. (26. FULL FUEL SUPPLY 6 hours)</p> <p>6.2 Low Temperature Test</p> <p>6.2.1 Verify steps 6.1 through 6.1.6 completed.</p> <p>6.2.2 Thermo-King turned ON and set to maintain $+80^{\circ}\text{F}$ ($\pm 5^{\circ}$) within the van. (Note: Use Thermo-King temperature indicator as the reference.)</p> <p>6.2.3 When van temperature is $+80^{\circ}\text{F}$ ($\pm 5^{\circ}\text{F}$) reduce chamber temperature to -35°F ($\pm 5^{\circ}\text{F}$).</p> <p>6.2.3.1 Record actual time -35°F ($\pm 5^{\circ}\text{F}$) is reached. This time shall be considered at the start of the test.</p> <p>Time <u>1500</u> Hours <u>9/20/62</u> Date</p>	<p><i>[Handwritten initials]</i></p>	<p>6.1.5 Verify still photos taken of internal instr. and test set-up. Method: visual</p> <p>6.2.3 Verify van temp. is $\pm 80^{\circ}\text{F} \pm 5^{\circ}\text{F}$ Record time, date Method: visual Time <u>1056</u> Date <u>9/20/62</u></p> <p>6.2.3.1 Verify cell temp is at $-35^{\circ}\text{F} \pm 5^{\circ}\text{F}$ (this is start of test) Record time and date. Method: visual Time <u>1130</u> Date <u>9/20/62</u></p> <p><i>[Handwritten initials]</i></p>			<p><i>[Handwritten initials]</i></p>

10C Temp #35"

MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		ISSUE DATE	PAGE	OF 10
ENGINEERING INSTRUCTIONS		INSPECTION SUMMARY	INSP. STAMP	REMARKS AND DATE
<p>6.2.4 The low temperature environment will be maintained until temperature equilibrium is reached on the motor surface, (Use TC R4 as the reference), and continued for an additional four (4) hours.</p> <p>6.2.4.1 Record stabilization time.</p> <p>TC R4 0700 Time 104562- Date</p> <p>6.2.4.2 Record stabilization temperature. Temp. +60</p> <p>Note: During the entire test, all TC's are to be read and manually recorded once each hour. (To include at least two (2) chamber thermocouples.)</p> <p>6.2.5 At the completion of 6.2.4, shut down Thermo-King, and maintain chamber temperature at -35° (±5°) for an additional four (4) hours. Continue to monitor and record all TC data. Record time test completed.</p> <p>1106 Time 104562 Date</p> <p>6.2.5.1 Thermo-King 245147 *</p> <p>6.2.6 Climatic chamber temperature returned to ambient. 153-</p> <p>6.3 High Temperature Test</p> <p>6.3.1 Verify full fuel supply on Thermo-King.</p> <p>* 2451 - 104562 5500</p>	<p>6.2.4 Cell temp. maintained at -35°F ± 5°F for four hours after temp. equilibrium is reached on the motor surface.</p> <p>Method: visual</p> <p>6.2.5 After completion of 6.2.4 above Thermo-King shut down and cell temp. maintained at -35°F ± 5°F for four hours.</p> <p>Method: visual</p>	<p>FINAL MOTOR TEMP -45°F AVE. VAN TEMP +35°F COLD-START ATTEMPT UNSUCCESSFUL F.M.</p>	<p>PR MK</p>	

ACC Temp #2511

MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		CODE 101	MEIS NO.	ISSUE DATE	PAGE <u>A</u> OF <u>10</u>
ENGINEERING INSTRUCTIONS		OP. INIT.	INSPECTION SUMMARY		INSP. STAMP
<p>6.3.2 Turn on Thermo-King unit and adjust for 80°F ($\pm 5^\circ$) within the van.</p> <p>6.3.3 When van interior stabilizes at +80°F ($\pm 5^\circ$), increase climatic-chamber temperature to +110°F ($\pm 5^\circ$). Record actual time the chamber reaches +110°F ($\pm 5^\circ$). This time shall be considered as test-start-time.</p> <p style="text-align: center;">0900 Time 8-13-62 Date</p> <p>6.3.4 The +110° environment shall be maintained for four (4) hours with the Thermo-King running. All temperatures shall be read and manually logged once each 15 minutes. Highest temperature recorded on the motor surface: <u>86</u> °F. (T-2)</p> <p>6.3.5 At the conclusion of the first four hour period, the Thermo-King shall be turned off and the chamber temperature continued at +110°F for four (4) additional hours. Continue all data readings during this four (4) hour period. <u>1306 hrs.</u></p> <p>6.3.6 At the conclusion of the second four (4) hour period, the climatic-chamber temperature may be reduced to ambient, and the Thermo-King turned-off. <u>1700 hrs.</u></p>		<p><i>[Signature]</i></p> <p><i>[Signature]</i></p> <p><i>[Signature]</i></p> <p><i>[Signature]</i></p>	<p>6.3.3 Verify van temp. is +80°F $\pm 5^\circ$F and cell temp. is +110°F $\pm 5^\circ$F and record. (This is considered start of test) Van temp. at 80° <u>8/13</u> date <u>0114</u> Cell temp. at +110° <u>8/13</u> date <u>0900</u> time Method: visual</p> <p>6.3.4 The cell +110° environment maintained for four hours during which time the Thermo-King is running. Method: visual COMPLETED 1300 hrs. 8-13.</p> <p>6.3.5 After completion of 6.3.4 above Thermo-King unit shut off and cell temp. maintained at +110°F this environment maintained for four hours. Method: visual</p>		<p>6.3.4. THE TYP. FOUR HOUR PERIOD PLACED 5 FEET IN FRONT OF THERMO-KING DURING ITS OPERATION. (4 hours)</p>

AGC Temp #2577

MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		WDB 101	MEIS NO.	ISSUE DATE	PAGE 4 OF 10
ENGINEERING INSTRUCTIONS		OP. INIT.	INSPECTION SUMMARY		INSP. STAMP
<p>6.4 Post-Test Operations</p> <p>6.4.1 Verify validity of all data.</p> <p>6.4.1.1 All records identified. (Record number, date, IC number vs channel assignment, etc.)</p> <p>6.4.2 External instrumentation cabling removed.</p> <p>6.4.3 All entries completed on this MEIS.</p> <p>6.4.4 Transportation Officer notified to arrange shipment of Utility Van Motor to:</p> <p>Aerojet-General Corporation Solid Rocket Plant Building 4915 Mirabel, California Attention: T. J. Harrell</p> <p>6.4.5 The completed MEIS, thermocouple recordings and any other test data or reports are to be given to the witnessing representative from AGC.</p> <p>7.0 I certify that the testing of the transporter, "Rocket Motor", was accomplished per the requirements set forth in this MEIS and Test Plan 752.</p>		<p><i>[Signature]</i></p>	<p>6.4 Identify all data and records with motor S/N, van S/N, and test objective</p> <p>Method: Indicate at the end of all records and data</p>		<p><i>[Stamp]</i></p>
<p>Signed: <i>[Signature]</i></p> <p>(Title) <i>[Signature]</i></p> <p>(Title) <i>[Signature]</i></p>		<p>7.0 Indicate by signature and title that the test was performed per this MEIS and MTR.</p> <p>Method: <i>[Signature]</i></p> <p>Signed: <i>[Signature]</i></p> <p>(Title) <i>[Signature]</i></p>			

AGC 3-052

MINUTEMAN ENGINEERING AND INSPECTION SUMMARY		CODE 101	MEIS NO.	ISSUE DATE	PAGE 10 OF 10
ENGINEERING INSTRUCTIONS	INSPECTION SUMMARY	INSP. STAMP	REMARKS AND DATE		
<p>Written by:</p> <p><i>J. D. Sohl</i></p> <p>J. D. Sohl Environmental Program Engineer Environmental Testing Department Solid Rocket Plant</p>	<p><i>F. L. K. K. K.</i> QC Planning</p> <p><i>M. M. M.</i> Quality Engineer</p>				

APPENDIX B

Temperature Surveillance Chart,
High- and Low-Temperature Tests of
Aerojet Utility Van



Page B-1

DAILY TEMPERATURE SURVEILLANCE																															
CHART NO. <u>2</u>		DATE <u>9 AUG 62</u>		TEST FACILITY <u>EGUN RFB</u>																											
RANGE <u>-100° to +300°</u>		RECORDER NO. <u>2</u>		SERIAL NO. <u>314315</u>																											
CHART SPEED <u>8.962</u>		CAL. DUE DATE <u>8/10/62</u>																													
MOTOR	CELL	T.C. LOC.	TRACE	TEMPERATURE READINGS																											
				1055	1215	1255	1400	1506	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200		
		C6	1	80	80	80	78	75	69	67	66	64	63	62	62	61	61	60	60	59	59	59	59	59	59	59	59	59	59	58	59
		C7	2	80	80	80	78	74	69	66	65	64	63	63	62	61	60	60	60	59	59	59	59	59	59	59	59	59	58	58	58
		C8	3	80	80	80	78	75	69	66	65	64	63	62	62	61	60	60	60	59	59	59	59	59	59	59	59	59	58	58	58
		C9	4	80	80	80	78	75	69	66	66	64	63	62	61	61	60	60	59	59	59	59	59	59	59	59	59	59	58	58	58
		CELL 5	5	35	-2	-12	-21	-27	-40	-38	-37	-38	-40	-37	-43	-38	-38	-40	-36	-38	-36	-36	-36	-36	-36	-36	-36	-36	-36	-36	-36
		REF 6	6	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
REMARKS				VERIFIED TRUE BY AFCC.																											
DATE	TIME	REMARKS																													
		CTM																													
		GRAVE																													
		DAY																													
		SWING																													

CHART NO. _____

RANGE -100°F to +300°F

CHART SPEED 280"/min.

DATE 10 JUL 62

TEST FACILITY EGLIN AFB

RECORDED NO. _____

SERIAL NO. 322-005

CAL. DUE DATE _____

PAGE 2 of 3

TEMPERATURE READINGS

MOTOR	CELL LOC.	T.C. LOC.	TRACE	TEMPERATURE READINGS																						
				110°	118°	120°	122°	124°	126°	128°	130°	132°	134°	136°	138°	140°	142°	144°	146°	148°	150°					
A7	A1	A2	1	58	56	55	48	46	44	44	40	38	38	11	15	18	77	69	68	80	72	79	81	94	89	95
			2	60	56	55	49	46	44	42	40	38	38	76	15	18	77	65	68	80	69	79	81	84	89	95
			3	60	56	54	48	46	44	42	40	38	38	77	15	18	77	69	68	80	72	79	81	84	89	95
			4	58	53	51	47	44	42	40	37	35	34	75	15	17	77	70	69	79	72	78	81	85	89	93
			5	59	54	52	47	44	42	40	38	36	34	75	15	17	76	70	69	78	72	77	80	84	88	91
A8	A3	A4	6	58	53	51	47	44	42	40	38	36	34	75	15	17	76	70	70	18	73	78	80	84	88	92
			7	58	52	50	45	42	40	38	35	33	32	74	15	17	76	71	70	77	73	77	80	84	88	90
			8	58	52	50	45	42	40	38	35	33	32	74	15	17	76	71	70	77	73	77	80	84	88	90
			9	56	52	50	45	42	40	38	35	33	32	74	14	16	76	71	71	77	74	77	80	84	88	89
			10	52	33	34	34	33	34	34	34	34	34	15	104	128	135	142	141	137	140	140	141	141	141	141
A9	A5	A6	11	57	56	53	49	46	44	43	40	38	38	77	15	18	77	68	68	80	72	79	82	86	89	94
			12	60	60	59	57	56	54	53	51	50	49	76	16	18	77	70	70	67	72	77	80	83	87	91
			13	60	56	54	50	48	46	44	42	40	39	77	15	18	77	68	68	80	71	79	82	85	89	94
			14	60	59	58	55	53	51	50	48	46	45	76	16	17	77	72	72	67	74	77	80	83	87	96
			15	430	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
A10	A7	A8	16	62	61	60	58	55	53	52	50	50	48	76	16	17	76	74	72	76	79	76	80	82	85	88
			17	57	52	50	45	42	40	37	35	33	32	74	14	16	76	75	72	76	79	76	81	85	89	98
			18	60	59	58	55	53	51	50	49	47	46													

AGC 3-047.500-1

CHART NO. 2

RANGE -100°F To +300°F

CHART SPEED _____

DATE 10 AUG 62

TEST FACILITY EGLIN AFB

RECORD NO. 2

SERIAL NO. 314315

CAL. DUE DATE _____

DAILY TEMPERATURE SURVEILLANCE

PAGE 2 of 3

5/10-62

TEMPERATURE READINGS

MOTOR	CELL	T.C. LOC.	TRACE	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
RECORD OF VAN → (-150°F)	C6	1		58	53	50	46	43	41	39	36	35	33											
	C7	2		58	51	48	43	40	37	34	32	30	29											
	C8	3		58	51	48	43	40	37	35	32	30	29											
	C9	4		58	51	43	43	40	37	35	32	30	29											
	CELL	5		-35	-36	-37	-37	-36	-38	-38	-39	-38	-37											
	REF	6		+15	+15	+15	+15	+15	+15	+15	+15	+15	+15											
				<div style="position: relative; height: 100px;"> <div style="position: absolute; top: 0; left: 0; right: 0; bottom: 0; border: 1px solid black; transform: rotate(45deg); opacity: 0.5;"> THERMISTOR 100°F TO 300°F 1/10" DIA 1/16" Bore </div> </div>																				

DATE _____

TIME _____

REMARKS

CTM

GRAVE

DAY

SWING

TEMPERATURE READINGS

VERIFIED TRUE BY AFQC

DATE	TIME	REMARKS	CTM
5-13	1700	END OF TEST	GRAVE
	1706	RE-START ATTEMPT OF THERMO-KING SUCCESSFUL - UNIT LEFT ON FOR 10 MINUTES	DAY
			SWING

APPENDIX C

Chronological List of Events,
High- and Low-Temperature Tests of
Aerojet Utility Van



ST Form 1013 Rev 2 Aerojet-General Corporation, SRP		TEST OPERATIONS MOTOR LOG OF TIME VS OPERATION		PAGE _____
AGC 3-128-631		ENVIRONMENTAL VERIFICATION - CLIMATIC		W.C. NO. 0625-26-014
		TYPE OF TEST		
C.R. NO. _____	N.A. _____	TEST ENGINEER _____	J. D. Sohl	
PROGRAM MINUTEMAN 2ND STAGE		TEST SERIES MM2-QZ-02S-TC01	SHEET 1	OF 4
TEST SPECIMEN AGC Utility Van, VR-1152A. S/N 37290; AF 348873				
DATE	TIME	OPERATION		
Sacto				
7-24-62	1420	Utility van arrives at Bldg. 4605 for thermocouple installation.		
		Instructions issued to Instr. Foreman. Work initiated. Completion estimated by 2300 hrs.		
7-25-62	0800	Instrumentation continues - approx. 6 hrs. work remain.		
	1430	Instrumentation completed (per Test Plan 752A).		
	1530	Van removed to 4615 pending shipment to Eglin AFB.		
7-26-62	1600	Van departed for Eglin AFB. Carrier is Leonard Bros. - Shipper # S35876.		
0-62	-	Van arrived O.K. at Eglin AFB. Notified by J. Cole (AGC - Eglin) that there will be a four (4) day delay getting into the climatic chamber due to chamber schedule slippage.		
Eglin AFB				
8-8-62	0900	Inspected van and interior instrumentation. Everything in satisfactory condition.		
	0930	Instrumentation group informed of test requirements. They will provide (2) Brown I-C 24 ch. recorders, and make hook-up to same. Unable to move van into chamber until late afternoon due to previous test in progress.		
	1100	Requested inspection coverage prior to start of test. Coordination meeting set up for 1300 hrs.		
	1545	End of day shift - lab cleared of all previous test equipment. Van brought to lab area. Calibration of (2) Brown recorders complete.		
8-9-62	0730	Van brought into climatic lab.		
	0830	Thermoking crankcase oil changed. (10W-30) put in.		
	1000	Instrumentation complete - photos taken. Thermo-King set to +80° and running O.K.		
	1030	Pull-down of climatic chamber to -35° begun.		
	1055	Temp. of motor (B-4) = 82°F.		
		Temp. of cell (aft) = +35°F.		
	1500	Cell temp. (fore) = -30°. Official start of test.		

C-1

ST Form 1013 Rev 2 Aerojet-General Corporation, SRP		TEST OPERATIONS MOTOR LOG OF TIME VS OPERATION		PAGE _____
		ENVIRONMENTAL VERIFICATION - CLIMATIC		W.C. NO. 0625-26-014
AGC 3-128-631		TYPE OF TEST		
C.R. NO. _____ N.A. _____		TEST ENGINEER J. D. Sohl		
PROGRAM MINUTEMAN 2ND STAGE		TEST SERIES MM2-QZ-02S-TC01	SHEET 2 OF 4	
TEST SPECIMEN AGC Utility Van, VR-1152A. S/N 37290; AF 348873				
DATE	TIME	OPERATION		
8-9-62	1502	Noticed intermittent operation of Thermo-King. Trouble is somewhere in switch-box.		
	1505	Refueled unit.		
	1519	Thermo-King back on - still intermittent operation. Lost 10 degrees in van.		
	1500 - 1645	Continuous intermittent operation of the unit. Trouble shooting the system disclosed faulty fuse holder/fuse. Repaired same.		
	1900	System working O.K. Refueled Thermo-King. Excess frost is noted forming on the condenser face (Thermo-King).		
	1915	An excessive amount of oil was found on the top side of the engine power section. Unable to determine source of leak.		
	2230	T.C. A-9 indicates 59+° - cell temp. @ van front is -31°. Accumulation of oil on engine increased; approx. 1/3 of condenser face is frost.		
8-10-62	0045	Re-fueled unit - heat off for approx. 5 minutes.		
	0250	Inspected van and Thermo-King. Only apparent trouble is the aforementioned oil leak and accumulation on top of engine. Oil level checked O.K.		
	0608	Re-fueled unit. Heat off for four (4) minutes. Oil level checked O.K. Still evidence of leakage. Fuel gauge is in-op.		
	1025	Checked voltage across heater fuses; 208 vt each leg. Oil dripping from power unit.		
	1106	Shut down Thermo-King. Oil level O.K.		
		This completes the test of the Thermo-King operation - four (4) hours of temp. stabilization on TC B4.		
		In Summary:		
		Van interior at +80°F @ 1030 hrs. on 8-9-62.		
		Start pull down of cell @ 1030 hrs. on 8-9-62.		
		Cell in spec at -35° (±5°) @ 1500 hrs. on 8-9-62.		
		Motor temp. stable (B-4) @ 60° 0700 hrs. on 8-10-62.		
		Thermo-King off (Stab. plus 4 hrs.) 1105 hrs. on 8-10-62.		
		Test complete - 1505 hrs. on 8-10-62.		

C-2

ST Form 1013 Rev 2 Aerojet-General Corporation, SRP		TEST OPERATIONS MOTOR LOG OF TIME VS OPERATION		PAGE _____
AGC 3-128-631		ENVIRONMENTAL VERIFICATION - CLIMATIC		W.O. NO. 0625-26-014
		TYPE OF TEST		
C.R. NO. _____ N.A. _____		TEST ENGINEER _____ J. D. Sohl		
PROGRAM MINUTEMAN 2ND STAGE		TEST SERIES MM2-QZ-02S-TC01	SHEET 3 OF 4	
TEST SPECIMEN AGC Utility Van, VR-1152A. S/N 37290; AF 348873				
DATE	TIME	OPERATION		
		Final motor temp. (B-4) +45°F.		
		Average van temp. +35°F.		
		Thermo-King re-start attempt: Unsuccessful.		
		Low-temp. warning light was on below 70°F.		
8-13-62	0645	High temperature (+140°) test scheduled for today. Climatic chamber maintained at +80° over the weekend.		
	0700	Thermo-King serviced with SAE 20W-40 oil and refueled.		
	0745	Motor and van at 80° (±5°) - chamber set for +140°. (Reads 95° @ 0747)		
	0900	Official start of four (4) hour test at +140° (±5°) with Thermo-King on.		
		Cell reading: 135° Forward		
		141° Aft		
		As all interior TC's are reading approx. 75°, I changed thermostat setting to +75° from +80° to prevent unit from going on heating cycle.		
	0915	Refrig. cycle manually turned on by again reducing thermostat setting - had to be certain system was still operational. All TC's showed rapid drop to around 70°.		
	0930	Reset to +75° on Thermo-stat. All temps. still around +70°.		
	1010	Reset to +78° to let van warm up. Temps. @ 68-70°.		
	1230	Temps. within van show steady rise (most around 84-86°). Thermo-King still running normally - although the suction pressure in the evaporator has risen from around 40 psi @ +75° to 68 psi @ 88°. (Thermostat is still set @ 78°.)		
	1300	End of four (4) hour period of Thermo-King operation.		
		Highest temp. on motor (B-2) is 86°.		
		Average van temperature is 88°.		
		Also noted that oil leak which was apparent during cold-temp test is not present. Gasoline gage hasn't worked throughout entire cold or hot tests.		
	1305	Thermo-King turned off.		
	1405	Re-started Thermo-King and ran for 1 min. to obtain head pressure reading as requested by STL Rep.		

C-3

<p>Aerojet-General Corporation Sacramento, California</p> <p>HIGH- AND LOW-TEMPERATURE TESTS OF THE AEROJET-GENERAL UTILITY VAN, by J. D. Sobel Technical Report, September 1962 6 PP. 18 illus. 3 Appendices AFRSD-TN-BSD-TDR-62-331 Unclassified Report</p> <p>The Aerojet-General Utility van successfully completed high- and low-temperature tests to verify the accepta- bility of the van as a transport vehicle for Minuteman second-stage operational motors. An analysis of the data obtained in the tests is presented.</p>	<p>Aerojet-General Corporation Sacramento, California</p> <p>HIGH- AND LOW-TEMPERATURE TESTS OF THE AEROJET-GENERAL UTILITY VAN, by J. D. Sobel Technical Report, September 1962 6 PP. 18 illus. 3 Appendices AFRSD-TN-BSD-TDR-62-331 Unclassified Report</p> <p>The Aerojet-General Utility van successfully completed high- and low-temperature tests to verify the accepta- bility of the van as a transport vehicle for Minuteman second-stage operational motors. An analysis of the data obtained in the tests is presented.</p>	<p>UNCLASSIFIED</p> <p>I. High- and Low-Temperature Tests of the Aerojet-General Utility Van</p> <p>1. Aerojet-General Corporation</p> <p>II. Air Force Ballistic Systems Division, Air Force Systems Command, USAF</p> <p>III. Contract No. AF 33(600)-36610</p> <p>UNCLASSIFIED</p>	<p>UNCLASSIFIED</p> <p>I. High- and Low-Temperature Tests of the Aerojet-General Utility Van</p> <p>1. Aerojet-General Corporation</p> <p>II. Air Force Ballistic Systems Division, Air Force Systems Command, USAF</p> <p>III. Contract No. AF 33(600)-36610</p> <p>UNCLASSIFIED</p>
<p>Aerojet-General Corporation Sacramento, California</p> <p>HIGH- AND LOW-TEMPERATURE TESTS OF THE AEROJET-GENERAL UTILITY VAN, by J. D. Sobel Technical Report, September 1962 6 PP. 18 illus. 3 Appendices AFRSD-TN-BSD-TDR-62-331 Unclassified Report</p> <p>The Aerojet-General Utility van successfully completed high- and low-temperature tests to verify the accepta- bility of the van as a transport vehicle for Minuteman second-stage operational motors. An analysis of the data obtained in the tests is presented.</p>	<p>Aerojet-General Corporation Sacramento, California</p> <p>HIGH- AND LOW-TEMPERATURE TESTS OF THE AEROJET-GENERAL UTILITY VAN, by J. D. Sobel Technical Report, September 1962 6 PP. 18 illus. 3 Appendices AFRSD-TN-BSD-TDR-62-331 Unclassified Report</p> <p>The Aerojet-General Utility van successfully completed high- and low-temperature tests to verify the accepta- bility of the van as a transport vehicle for Minuteman second-stage operational motors. An analysis of the data obtained in the tests is presented.</p>	<p>UNCLASSIFIED</p> <p>I. High- and Low-Temperature Tests of the Aerojet-General Utility Van</p> <p>1. Aerojet-General Corporation</p> <p>II. Air Force Ballistic Systems Division, Air Force Systems Command, USAF</p> <p>III. Contract No. AF 33(600)-36610</p> <p>UNCLASSIFIED</p>	<p>UNCLASSIFIED</p> <p>I. High- and Low-Temperature Tests of the Aerojet-General Utility Van</p> <p>1. Aerojet-General Corporation</p> <p>II. Air Force Ballistic Systems Division, Air Force Systems Command, USAF</p> <p>III. Contract No. AF 33(600)-36610</p> <p>UNCLASSIFIED</p>